





Long Term Resource Monitoring Program

Vegetation

# 1999 Annual Status Report: Submersed and Rooted Floating–Leaf Vegetation in Pools 4, 8, 13, and 26 of the Upper Mississippi River, and La Grange Pool of the Illinois River

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- ▶ Multiyear Trends of Aquatic Vegetation

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# **Preface**

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U. S. Army Corps of Engineers Environmental Management Program. The LTRMP is being implemented by the Upper Midwest Environmental Sciences Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem, given its multiuse character. The long-term goals of the program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report presents the results of aquatic vegetation stratified random sampling surveys conducted by field station personnel under the direction of the Upper Midwest Environmental Sciences Center. Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River were surveyed. This document satisfies Task 2.2.4.6, *Evaluate and Summarize Annual Present-day Results* under Goal 2, *Monitor Resource Change* of the Operating Plan (U.S. Fish and Wildlife Service 1993). The purpose of this report is to provide a summary of data regarding the distribution and abundance of submersed and floating–leaf vegetation collected from the field stations. This document was developed with funding provided by the Long Term Resource Monitoring Program.

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# **Abstract**

Vegetation sampling was conducted between June 15 and August 6, 1999, in Pools 4, 8, 13, and 26 of the Upper Mississippi River (UMR) and La Grange Pool of the Illinois River at 2,877 sites to quantify the status of rooted floating-leaf and submersed aquatic vegetation. Two exotic species, Eurasian watermilfoil and curly pondweed, were recorded along with 21 indigenous species. One species, ribbon-leaf pondweed, rarely found in the Mississippi River, was recorded in Pool 4. The species composition and indices of frequency and abundance of submersed aquatic vegetation within the study pools was similar to that reported in 1998. Submersed aquatic vegetation was abundant in the upper impounded pools (4, 8, and 13) of the UMR and scant or below the detection limit of the sampling protocol in Pool 26 of the UMR, and La Grange Pool of the Illinois River. Many statistically significant changes were detected at smaller scales (pool or stratum within a pool), but 2 years of data is an insufficient time frame to observe a trend.

**Key words:** Aquatic macrophyte, aquatic vegetation, Illinois River, Mississippi River, and monitoring, status and trend.

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# Introduction

Aquatic vegetation in the <u>Upper Mississippi River System</u> (UMRS) provides food and habitat to fish and wildlife and is a vital component of this nationally significant ecosystem (Public Law 99-662, Upper Mississippi River Management Act of 1986). The UMRS is also a nationally significant navigation system. The building of locks and dams in the Upper Mississippi and Illinois Rivers for commercial navigation greatly expanded the rivers' backwater areas in which submersed aquatic vegetation flourished following the development. However, following a severe drought in the basin, aquatic vegetation in the Mississippi River experienced a drastic decline between 1989 and 1994 (Fischer and Claflin 1995; Rogers et al. 1995; Wiener et al. 1998; Tyser et al. 2001). As of 1999, the amount of submersed aquatic vegetation remains substantially lower than the historical high levels recorded in the 1970s.

Through the Upper Mississippi River Management Act of 1986, Congress established the Environmental Management Program of the UMRS in 1986 to ensure the coordinated development and enhancement of the Upper Mississippi River System. The Environmental Management Program consists of five elements, including Habitat Rehabilitation and Enhancement Projects (HREP), Long Term Resources Monitoring Program (LTRMP), Recreation Projects, Economic Impacts of Recreation Study, and Navigation Monitoring. Aquatic vegetation in the UMRS is monitored as a component of the LTRMP, along with the fish, water quality, and macroinvertebrate components. The LTRMP is administered by the U.S. Army Corps of Engineers and implemented by the Upper Midwest Environmental Sciences Center (UMESC) of the U.S. Geological Survey in partnerships with the Illinois Department of Natural Resources, Iowa Department of Natural Resources, Minnesota Department of Natural Resources, Missouri Department of Conservation, and Wisconsin Department of Natural Resources. Five key pools have been sampled for aquatic vegetation using stratified random sampling protocols since 1998 including Pools 4, 8, 13, and 26 of the Mississippi River and La Grange Pool of the Illinois River.

The objective of stratified random sampling was to accumulate data on aquatic vegetation over a long term (>50 years) using a standardized protocol across the system. The data provide information on the distribution and abundance of vegetation

within pools for the protection and enhancement of the Upper Mississippi River System. Although data on emergent macrophytes, filamentous alga, and duckweeds were included in the investigation, they are not reported here because our focus was on submersed and rooted floating—leaf vegetation. The full suite of data (inclusive of submersed, rooted floating—leaf, emergents, algae, and duckweeds) are archived in the UMESC database and are openly available online at <a href="http://www.umesc.usgs.gov/data\_library/vegetation/vegetation\_page.html">http://www.umesc.usgs.gov/data\_library/vegetation/vegetation\_page.html</a>.

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# **Study Areas**

- Pool 4
- Pool 8
- Pool 13
- Pool 26
- La Grange Pool

**Navigation Pool 4** is 73.3 km (44 river miles) long and includes 14,700 ha (36,300 acres) of aquatic habitat. It is located between Lock and Dam 3 (above Red Wing, Minnesota) and Lock and Dam 4 (Alma, Wisconsin). Major tributaries include the Cannon and Vermillion Rivers on the Minnesota side and the much larger Chippewa River on the Wisconsin side. Lake Pepin, a riverine lake created by the Chippewa River delta, is located in the middle of Pool 4. The location of Lake Pepin divides the rest of the pool into upper Pool 4 and lower Pool 4. The smaller backwaters of upper Pool 4 have been degraded by sedimentation, whereas the larger backwaters of lower Pool 4 are much better habitat for vegetation.

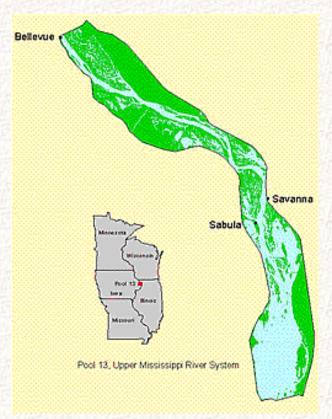


Click on the image for a larger view of Pool 4

Navigation Pool 8 is 38.8 km (23.3 river miles) long and is bounded by Lock and Dam 7 (Dresbach, Minnesota) to the north and Lock and Dam 8 (Genoa, Wisconsin) to the south. It encompasses 9,000 ha (22,100 acres) of aquatic habitat. Major tributaries include the Black, Root, and La Crosse Rivers. The upper section of Pool 8 has high bank islands adjacent to the main channel, deep secondary channels, and backwater sloughs. The middle section contains low islands, braided channels, and small backwater sloughs. The lower section is a large open expanse of water.



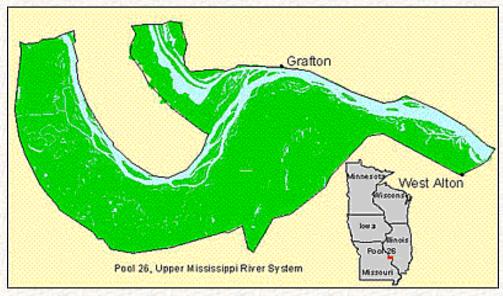
Click on the image for a larger view of Pool 8



Click on the image for a larger view of Pool 13

Navigation Pool 13 is 52.1 km (34.2 river miles) in length and is bounded by Lock and Dam 12 (Bellevue, Iowa) to the north and Lock and Dam 13 (Fulton, Illinois) to the south. It encompasses 11,400 ha (28,100 acres) of aquatic habitat. Similar to pools upstream, Pool 13 contains many high bank islands adjacent to the main channel in the upper section, braided backwater channels and sloughs in the middle section, and a large open lake-like area in the lower section of the pool. Major tributaries include the Apple and Plum Rivers on the Illinois side and Maquoketa and Elk Rivers on the lowa side.

The **Navigation** Pool 26 study area includes water bodies along the Upper Mississippi River from Lock and Dam 25 (Winfield, Missouri) to Lock and Dam 26 (Alton, Illinois) and the lower Illinois River from its confluence with the Mississippi River north to Illinois River mile 12. This reach of the two rivers is bordered by high bluffs on the Illinois side and low elevation floodplain on the Missouri side. The reach encompasses 9,500 ha (23,700 acres) of aquatic habitat. Presently, most of the backwaters of the lower Illinois River are isolated from the river by low levees. Likewise, many of the secondary channels of the Mississippi River are isolated from the river on the upstream side.



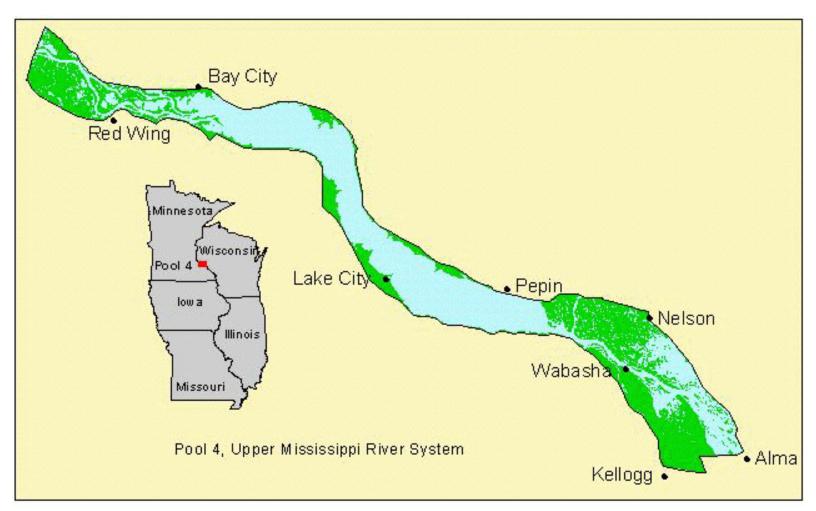
Click on the image for a larger view of Pool 26

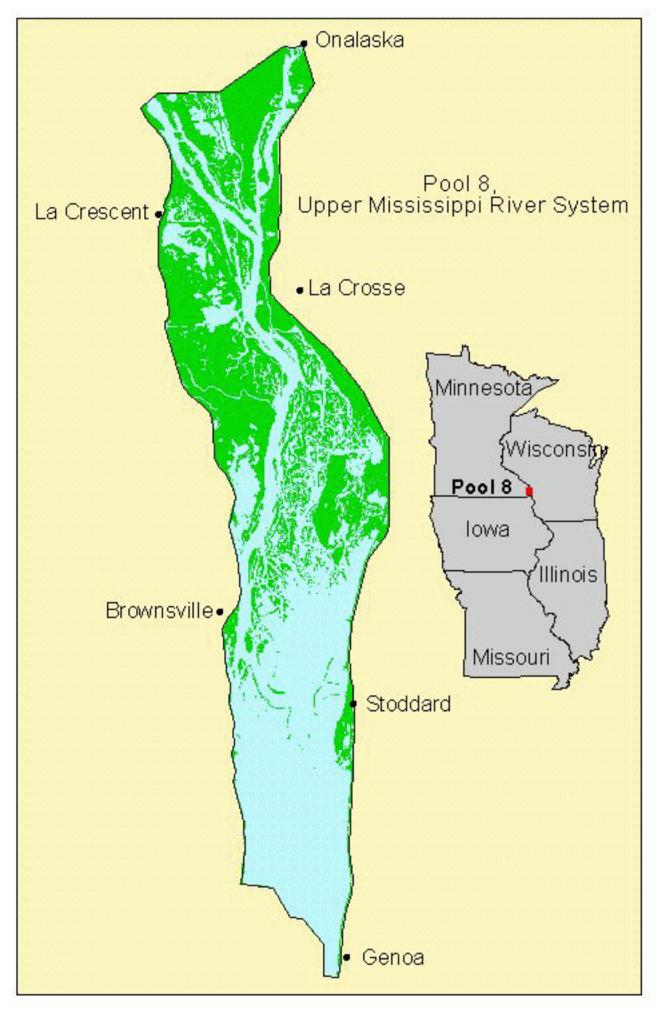
La Grange Pool on the Illinois River is about 130 km (80 river miles) long and encompasses 10,750 ha (26,500 acres) of aquatic habitat. It is bounded by Peoria Lock and Dam to the north and La Grange Lock and Dam to the south. This reach has the highest proportion of backwaters, except for Pool 4, but these backwaters are highly degraded by excessive sedimentation over the last 150 years. Many backwaters are isolated by low levees. Major tributaries include the Sangmon, Mackinaw, and LaMoine Rivers.



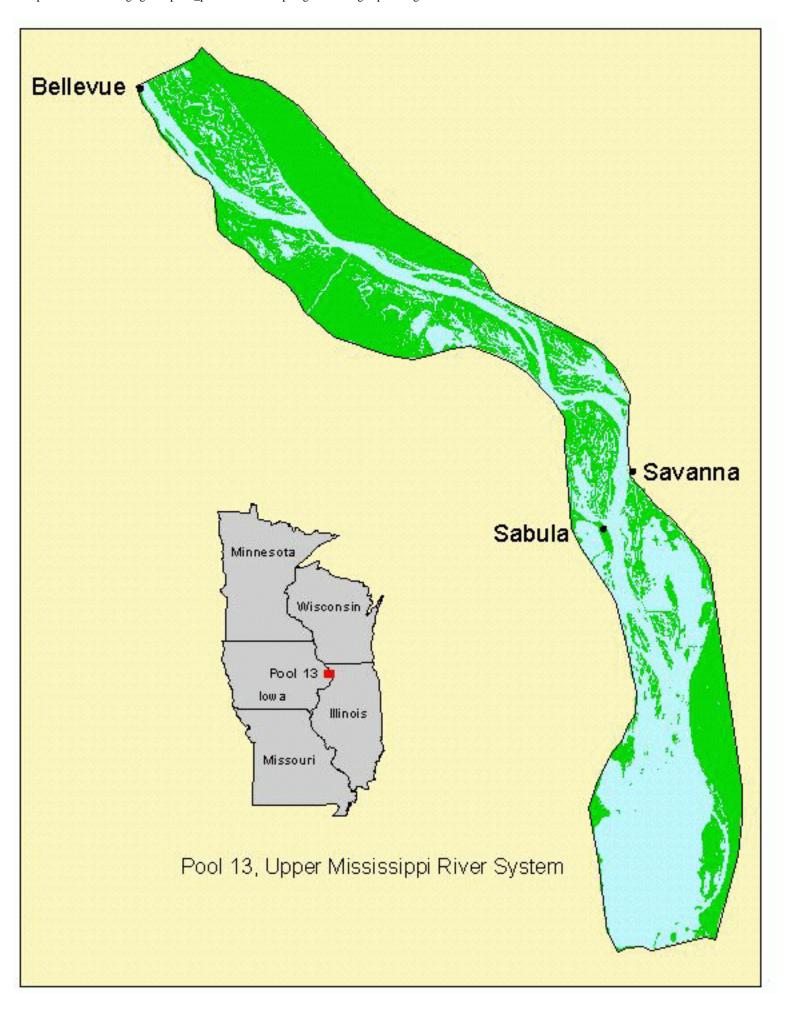
Click on the image for a larger view of La Grange Pool

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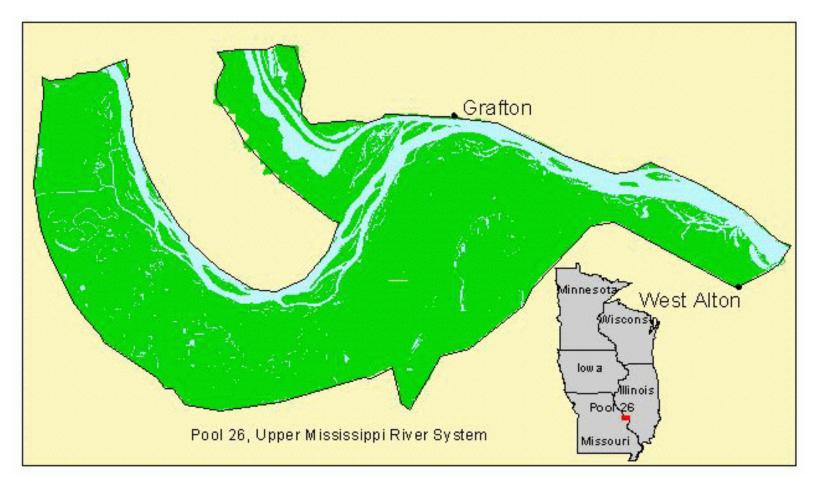


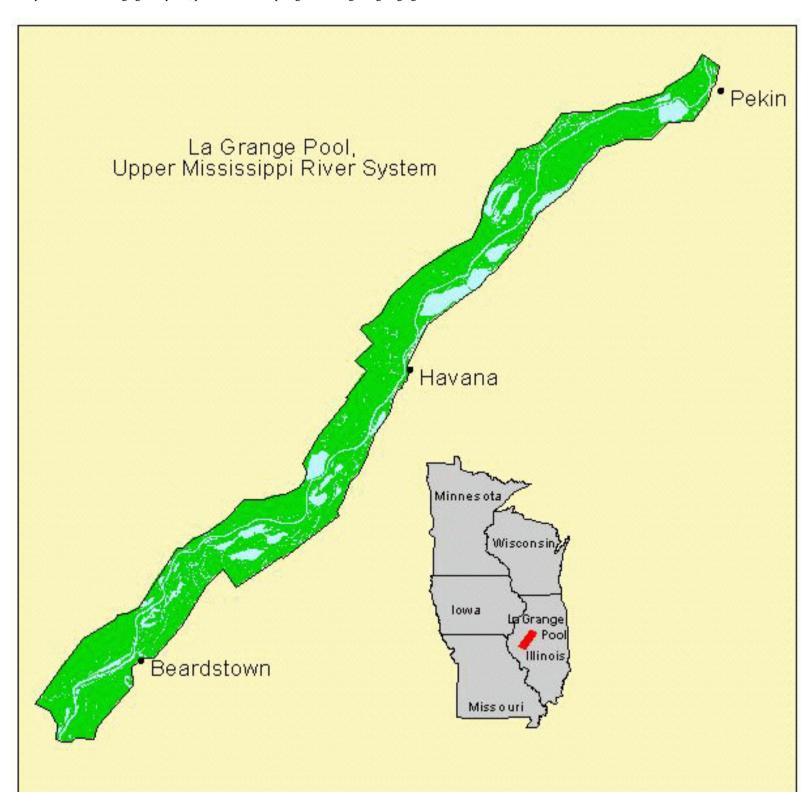






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# **Methods**

Sampling procedures were described in detail in <u>Yin et al. (2000)</u>. The following is a brief description of the overall design.

#### Stratification

Stratified random sampling was initiated in 1998. Sampling sites were distributed in shallow water areas where water depth was less than or equal to 3 m deep at flat-pool condition. After 1998, sampling sites were distributed in less than or equal to 2.5 m depth. Deeper water areas most likely do not support aquatic vegetation. Shallow water areas were divided into general habitat types (strata), including main channel borders, secondary channels, contiguous backwaters, isolated backwaters, and impounded areas. Sampling efforts were generally proportional to acreage and perceived habitat heterogeneity of each stratum, except for the isolated backwater areas whose sampling sizes were kept small to ensure a timely completion of the investigation. Some areas were excluded from the sampling areas because of safety concerns and accessibility difficulties.

## **Site Selection**

Sites were selected using a random number generator. A 50- X 50-m grid was generated and overlaid onto the stratified aquatic areas. Nodes of the grid were geospatially registered (Universal Transverse Mercator coordinates), and nodes that fell in the sampling strata were eligible for selection as sites. We navigated to the general area of a site using an enlarged hard-copy map and then switched to global positioning system (GPS) equipment with differentially corrected signals as the boat approached the targeted location. The boat was anchored at bow and stern when both the easting and northing coordinates displayed on the GPS unit were within 10 m (- or +) of their respective target readings. The actual GPS coordinates were read and recorded twice at each site, once immediately after the boat had been anchored and again before the boat was released for departure.

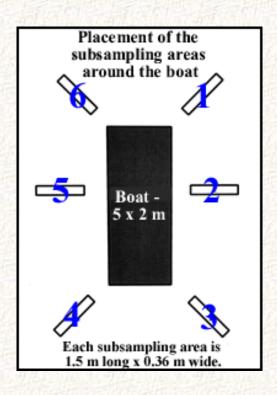
# **Equipment and Definitions**

Submersed aquatic vegetation was collected using a long-handled, double-headed rake modified from Jessen and Lound (1962) and Deppe and Lathrop (1992). The rake is 36 cm (14 inches) wide, has 14, 5-cm (2 inches) long teeth on each side, and was made by welding two square-headed garden rakes together. The teeth are divided and marked into five equal parts (or 20% increments). The handle is about 3 m long, with a rope extension, and is scaled at 10-cm increments. Aquatic



vegetation or aquatic species refer to the following plant types or life forms: submersed (S) and rooted floating–leaf (F).

# The Site and Subsampling Areas



Each site had six subsampling areas, each of which was a rectangular area approximately 1.5 m long and 0.35 m wide (the width of the rake head). One subsampling area was located off each corner of the boat and the other two were located, one each, off the left and right sides.

# Sampling and Data Recording

Individual species and different life forms of aquatic vegetation were recorded as either present or absent at each subsampling area based on visual examination and a rake sample. When present, submersed species and the filamentous algae were given a **density rating** (see table at lower left) based on their thickness on the rake teeth. When present, rooted floating—leaf and emergent species were given a percent **cover rating** (see table at lower right). Species that had not been recorded in the six subsampling areas but were observed at the site were recorded and marked as "additional species." Fassett (1957), Voss (1972, 1985) and Gleason and Cronquist (1991) were the primary references used for plant identification. Scientific nomenclature and common names are based on those found in the U.S. Department of Agriculture's PLANTS Database (http://plants.usda.gov/).

Submersed vegetation density ratings					
Percent of rake teeth filled	Density rating				
81-100	5				
61-80	4				
41-60	3				
21-40	2				
1-20	0/-1/-0/				
no plants retrieved	0				

Rooted floating-leaf vegetation cover ratings						
Percent of area covered	Cover rating					
81-100	5					
61-80	4					
41-60	3					
21-40	2					
1-20	1					
none	0					

# **Computation of Summary Indexes**

#### Frequency

Frequency values in this report are computed by dividing the number of sites where a species was recorded by the number of sites investigated in the stratum, and then multiplied by 100 to convert it into a percentage.

$$F = \frac{\textit{sites where species A occurs in stratum } X}{\textit{total number of sites in stratum } X} \times 100$$

The frequency value in a pool is computed by averaging the frequency values of the shallow water strata, weighted by acreage:

$$(\bar{F} = \frac{\sum_{j=1}^{m} F_{j} \cdot S_{j}}{\sum_{j=1}^{m} S_{j}})$$
 where  $F_{j}$  is the frequency in stratum  $j$  and  $S_{j}$  is the acreage of stratum  $j$ .

#### Abundance Index

An index is created to measure the quantity of a submersed species using both presence or absence and plant density rating data recorded in the six subsampling areas. We call it the abundance index to differentiate it from the frequency index. The abundance index is computed according to the following formula:

$$A = \frac{\log 2(1 + \sum_{i=1}^{6} V_i) + 3^{\log 2(1 + \frac{\sum_{i=1}^{6} (R_i - V_i)}{6})} - 1}{14.6260} \times 100$$

where  $V_i$  is the presence or absence (1,0) and  $R_i$  is the plant density ranking (0,1,2,3,4,5) data for the  $i^{th}$  subsampling areas at the site (i=1,2,3,4,5,6). Data are treated before computation so that  $V_i$ =1 if  $R_i$ >=1 and, vice versa,  $R_i$ >=1 if  $V_i$ =1. The abundance index for a stratum is computed as the simple average of all its

sites. 
$$(A = \frac{\sum_{j=1}^{n} A_j}{n})$$

The abundance index for a pool is computed as the average of all shallow water strata, weighted by acreage:

$$A = \frac{\sum_{j=1}^{m} A_j \cdot S_j}{\sum_{j=1}^{m} S_j}$$

where  $A_j$  is the abundance index of the species in stratum j and  $S_j$  is the acreage of stratum j.

Percent Cover (Rooted floating-leaf life form)

The percent cover of rooted floating—leaf life forms in a stratum is computed using the following formula:

$$C = \frac{\sum_{j=1}^{m} L_j \cdot A}{M}$$

where  $L_j$  is the cover rating at individual sites and A is the midpoint of the corresponding percent cover, and M is the total number of sites in the stratum. Percent cover in a pool is computed as the average of all shallow water strata, weighted by acreage:

$$C = \frac{\sum_{j=1}^{m} C_j \cdot S_j}{\sum_{j=1}^{m} S_j}$$

where  $C_i$  is percent cover in stratum j and  $S_i$  is the acreage of stratum j.

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# 1999 Results in Pool 4 of the Upper Mississippi River

# **Sampling Effort**

Sampling was conducted from June 15 to July 27, 1999. Of the 550 sites targeted, 547 were sampled (Figure 1).

# **Submersed Aquatic Vegetation**

The status of submersed aquatic vegetation (SAV) in Pool 4 varied among the strata sampled. Isolated backwaters had the highest frequency of SAV (<u>Table 2</u>; <u>Figure 2</u>), followed by lower pool contiguous backwaters. In general, lower pool contained significantly more SAV than upper pool (48.9% and 18.5%, respectively). The SAV covered about 38% of the shallow water areas poolwide.

A total of 15 SAV species were recorded in the entire pool; however, most species were found either in lower pool strata or isolated backwaters. Of the nine strata sampled, only three (isolated backwaters, lower pool contiguous backwaters, and lower pool secondary channels) supported a rich diversity of species (10 or more species per strata). Two strata (lower pool main channel border and lower Lake Pepin) supported moderate species diversity (seven species each). In the upper portion of the pool, all strata had few or no species (zero-five species). Coontail was the most abundant species found poolwide, followed closely behind by sago pondweed and Canadian waterweed. Wildcelery was most abundant in lower pool contiguous backwaters and secondary channels of the lower pool.

# **Rooted Floating–Leaf Vegetation**

Of the three rooted floating—leaf species present in Pool 4, only two were recorded in 1999; white waterlily and American lotus. Poolwide, the percent frequency of all rooted floating—leaf species was fairly sparse (9.5%) and was dominated by white waterlily (8.5%). Isolated backwaters had the highest percent cover of rooted floating—leaf vegetation that consisted entirely of white waterlily. The only stratum with American lotus was the lower pool contiguous backwater. Aside from isolated backwater sites,

rooted floating—leaf species were only recorded in contiguous backwaters of both lower and upper pool, and secondary channels of the lower pool. All other strata were void of rooted floating—leaf species.

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**Table 2.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

Common name	Contiguous backwater, upper n = 75		backwater, upper backwater, lower			Isolated backwater n = 32		
(Scientific name)	Freq	Al	Freq	Al	Freq	Al		
bladderwort, common (Utricularia macrorhiza)	-	-	0.6 ± 0.6	<0.1 ± <0.1	-	-		
buttercup, longbeak (Ranunculus longirostris)	-	-	-	-	3.1 ± 3.1	0.4 ± 0.4		
coontail (Ceratophyllum demersum)	4.0 ± 2.3	0.6 ± 0.3	38.8 ± 3.9	5.2 ± 0.6	68.8 ± 8.3	14.0 ± 2.5		
pondweed, curly (Potamogeton crispus)	1.3 ± 1.3	0.1 ± 0.1	15.6 ± 2.9	1.8 ± 0.4	12.5 ± 5.9	1.2 ± 0.6		
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	10.0 ± 2.4	1.0 ± 0.2	12.5 ± 5.9	1.7 ± 0.9		
pondweed, horned (Zannichellia palustris)	-	-	1.3 ± 0.9	0.2 ± 0.1	-	-		
pondweed, leafy/small (Potamogeton foliosus/ pusillus)	-	-	16.9 ± 3.0	1.9 ± 0.4	46.9 ± 9.0	6.4 ± 1.3		
pondweed, longleaf ( <i>P. nodosus</i> )	1.3 ± 1.3	0.2 ± 0.2	7.5 ± 2.1	$0.9 \pm 0.3$	9.4 ± 5.2	1.0 ± 0.6		
pondweed, ribbonleaf ( <i>P. epihydrus</i> )	-	-	-	-	-	-		
pondweed, sago (P. pectinatus)	26.7 ± 5.1	3.2 ± 0.7	10.0 ± 2.4	1.4 ± 0.4	75.0 ± 7.8	11.0 ± 1.4		
stargrass, water (Heteranthera dubia)	-	-	32.5 ± 3.7	3.9 ± 0.5	3.1 ± 3.1	0.2 ± 0.2		
watermilfoil, Eurasian (Myriophyllum spicatum)	-	-	26.3 ± 3.5	3.0 ± 0.4	-	-		
waternymph, nodding (Najas flexilis)	-	-	4.4 ± 1.6	0.5 ± 0.2	15.6 ± 6.5	1.7 ± 0.8		

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

A T I I B I I A T						
waterweed, Canadian		0.1 ±	40.0 ±		21.9 ±	
(Elodea canadensis)	1.3 ± 1.3	0.1	3.9	$5.3 \pm 0.6$	7.4	2.8 ± 1.0
wildcelery			30.6 ±			
(Vallisneria americana)	-	-	3.7	$4.1 \pm 0.5$	-	-
			66.3 ±		81.3 ±	16.9 ±
all submersed species	29.3 ± 5.3	$3.6 \pm 0.7$	3.8	$10.8 \pm 0.7$	7.0	2.3
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American						
(Nelumbo lutea)	-	-	5.6 ± 1.8	$0.9 \pm 0.4$	-	-
waterlily, white		1.1 ±	18.8 ±		34.4 ±	
(Nymphaea odorata)	5.3 ± 2.6	0.6	3.1	$3.9 \pm 0.9$	8.5	4.1 ± 1.2
all rooted floating-leaf		1.1 ±			34.4 ±	
species			04000	10 10	0.5	44 40
species	5.3 ± 2.6	0.6	21.3 ± 3.2	$4.6 \pm 1.0$	8.5	4.1 ± 1.2

Table 2. Continued.

Common name	up	Pepin, per 65	Lake Pepin, lower n = 35		Main channel border, upper n = 12		
(Scientific name)	Freq	Al	Freq	Al	Freq	Al	
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	-	-	-	-	
buttercup, longbeak ( <i>Ranunculus longirostris</i> )	-	-	-	-	-	-	
coontail ( <i>Ceratophyllum demersum</i> )	-	-	2.9 ± 2.9	0.3 ± 0.3	-	-	
pondweed, curly ( <i>Potamogeton crispus</i> )	-	-	-	-	-	-	
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	-	-	-	-	
pondweed, horned ( <i>Zannichellia palustris</i> )	-	-	-	-	-	-	
pondweed, leafy/small ( <i>Potamogeton foliosus/</i> <i>pusillus</i> )	-	-	8.6 ± 4.8	$0.6 \pm 0.3$	-	-	
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	-	-	-	-	
pondweed, ribbonleaf ( <i>P. epihydrus</i> )	-	-	-	-	-	-	
pondweed, sago ( <i>P. pectinatus</i> )	16.9 ± 4.7	$2.3 \pm 0.7$	2.9 ± 2.9	$0.3 \pm 0.3$	16.7 ± 11.2	1.1 ± 0.8	

stargrass, water ( <i>Heteranthera dubia</i> )	-	-	2.9 ± 2.9	0.2 ± 0.2	-	-
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	-	-	-	-	-	-
waternymph, nodding (Najas flexilis)	-	-	8.6 ± 4.8	1.5 ± 0.8	-	-
waterweed, Canadian (Elodea canadensis)	-	-	8.6 ± 4.8	1.2 ± 0.7	-	-
wildcelery ( <i>Vallisneria americana</i> )	-	-	5.7 ± 4.0	0.7 ± 0.5	-	-
all submersed species	16.9 ± 4.7	2.3 ± 0.7	8.6 ± 4.8	1.6 ± 0.9	16.7 ± 11.2	1.1 ± 0.8
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American ( <i>Nelumbo lutea</i> )	-	-	-	-	-	-
waterlily, white (Nymphaea odorata)	-	-	-	-	-	-
all rooted floating-leaf species	-	-	-	-	-	-

Table 2. Continued.

Common name	Main ch border, n =	chai up	ndary nnel, per = 61	Secondary channel, lower n = 59		
(Scientific name)	Freq	Freq Al		Al	Freq	Al
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	-	-	-	-
buttercup, longbeak ( <i>Ranunculus longirostris</i> )	-	-	-	-	-	-
coontail (Ceratophyllum demersum)	2.1 ± 2.1	0.1 ± 0.1	-	-	20.3 ± 5.3	1.6 ± 0.4
pondweed, curly (Potamogeton crispus)	2.1 ± 2.1	0.1 ± 0.1	-	-	11.9 ± 4.2	1.4 ± 0.5
pondweed, flatstem (P. zosteriformis)	-	-	-	-	-	-
pondweed, horned ( <i>Zannichellia palustris</i> )	6.3 ± 3.5	0.7 ± 0.4	-	-	1.7 ± 1.7	0.3 ± 0.3
pondweed, leafy/small (Potamogeton foliosus/pusillus)	-	-	-	-	5.1 ± 2.9	0.3 ± 0.2

pondweed, longleaf						
(P. nodosus)	-	-	-	-	8.5 ± 3.7	1.2 ± 0.6
pondweed, ribbonleaf ( <i>P. epihydrus</i> )	-	-	-	-	1.7 ± 1.7	0.2 ± 0.2
pondweed, sago ( <i>P. pectinatus</i> )	10.4 ± 4.5	1.4 ± 0.7	-	-	18.6 ± 5.1	2.4 ± 0.7
stargrass, water (Heteranthera dubia)	10.4 ± 4.5	0.9 ± 0.4	-	-	10.2 ± 4.0	1.1 ± 0.5
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	-	-	-	-	8.5 ± 3.7	0.8 ± 0.4
waternymph, nodding (Najas flexilis)	-	-	-	-	-	-
waterweed, Canadian (Elodea canadensis)	4.2 ± 2.9	0.3 ± 0.2	-	-	18.6 ± 5.1	2.0 ± 0.6
wildcelery ( <i>Vallisneria americana</i> )	10.4 ± 4.5	1.3 ± 0.6	-	-	20.3 ± 5.3	2.8 ± 0.8
all submersed species	20.8 ± 5.9	2.4 ± 0.8	-	-	37.3 ± 6.3	5.2 ± 1.0
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (Nelumbo lutea)	-	-	-	-	-	<del>-</del>
waterlily, white (Nymphaea odorata)	-	-	-	-	1.7 ± 1.7	0.8 ± 0.8
all rooted floating-leaf species	-	-	-	-	1.7 ± 1.7	$0.8 \pm 0.8$

Table 2. Continued.

Common name		4, upper = 213		4, lower = 302	Pool 4 n = 547	
(Scientific name)	Freq	Al	Freq	Al	Freq	Al
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	0.4 ± 0.4	<0.1 ± <0.1	0.2 ± 0.2	<0.1 ± <0.1
buttercup, longbeak ( <i>Ranunculus longirostris</i> )	-	-	-	-	0.1 ± 0.1	<0.1 ± <0.1
coontail (Ceratophyllum demersum)	1.1 ± 0.6	0.1 ± 0.1	27.2 ± 2.5	3.5 ± 0.4	18.0 ± 1.4	2.6 ± 0.2
pondweed, curly (Potamogeton crispus)	0.4 ± 0.4	<0.1 ± <0.1	11.3 ± 1.9	1.3 ± 0.2	6.8 ± 1.0	0.8 ± 0.1
pondweed, flatstem (P. zosteriformis)	-	-	6.2 ± 1.5	0.6 ± 0.2	3.9 ± 0.8	0.4 ± 0.1

Table 2. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

pondweed, horned (Zannichellia palustris)	-	-	1.5 ± 0.7	0.2 ± 0.1	0.8 ± 0.4	0.1 ± 0.1
pondweed, leafy/small (Potamogeton foliosus/ pusillus)	-	-	12.6 ± 2.1	1.3 ± 0.3	8.8 ± 1.2	1.0 ± 0.1
pondweed, longleaf ( <i>P. nodosus</i> )	0.4 ± 0.4	0.1 ± 0.1	5.7 ± 1.2	0.7 ± 0.2	3.6 ± 0.8	0.4 ± 0.1
pondweed, ribbonleaf ( <i>P. epihydrus</i> )	-	-	0.2 ± 0.2	<0.1 ± <0.1	0.1 ± 0.1	<0.1 ± <0.1
pondweed, sago ( <i>P. pectinatus</i> )	17.8 ± 3.2	2.3 ± 0.5	9.8 ± 1.7	1.3 ± 0.3	16.0 ± 1.7	2.1 ± 0.2
stargrass, water ( <i>Heteranthera dubia</i> )	-	-	22.8 ± 2.4	2.7 ± 0.3	12.4 ± 1.3	1.5 ± 0.2
watermilfoil, Eurasian (Myriophyllum spicatum)	-	-	17.3 ± 2.2	1.9 ± 0.3	9.3 ± 1.2	1.0 ± 0.1
waternymph, nodding (Najas flexilis)	-	-	4.2 ± 1.3	0.5 ± 0.2	2.9 ± 0.8	0.4 ± 0.1
waterweed, Canadian (Elodea canadensis)	0.4 ± 0.4	<0.1 ± <0.1	28.9 ± 2.6	3.7 ± 0.4	16.6 ± 1.5	2.1 ± 0.2
wildcelery ( <i>Vallisneria americana</i> )	-	-	23.3 ± 2.5	3.1 ± 0.4	12.5 ± 1.3	1.7 ± 0.2
all submersed species	18.5 ± 3.2	2.4± 0.5	48.9 ± 2.6	7.8 ± 0.5	37.6 ± 2.0	5.9 ± 0.3
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (Nelumbo lutea)	-	-	3.5 ± 1.1	0.6 ± 0.2	1.9 ± 0.6	0.3 ± 0.1
waterlily, white (Nymphaea odorata)	1.4 ± 0.7	0.3 ± 0.2	11.9 ± 1.9	2.5 ± 0.9	8.5 ± 1.1	1.6 ± 0.3
all rooted floating-leaf species	1.4 ± 0.7	0.3 ± 0.2	13.4 ± 2.0	3.0 ± 0.9	9.3 ± 2.0	1.9 ± 0.3

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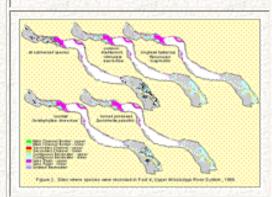
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**Figure 2.** Sites where species were recorded in Pool 4, Upper Mississippi River System, 1999.

#### **Image Preview**

#### **Figure - Description**



<u>Figure 2</u>. Species: all submersed species, common bladderwort (*Utricularia macrorhiza*), longbeak buttercup (*Ranunculus longirostris*), coontail (*Ceratophyllum demersum*), and horned pondweed (*Zannichellia palustris*).

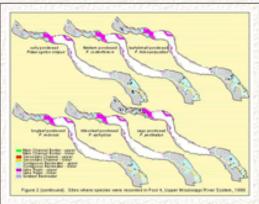


Figure 2. Continued. Species: curly pondweed (*Potamogeton crispus*), flatstem pondweed (*P. zosteriformis*), leafy/small pondweed (*P. foliosus/pusillus*), longleaf pondweed (*P. nodosus*), ribbonleaf pondweed (*P. epihydrus*), and sago pondweed (*P. pectinatus*).

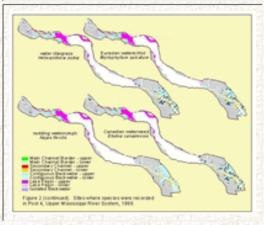


Figure 2. Continued. Species: water stargrass (Heteranthera dubia), Eurasian watermilfoil (Myriophyllum spicatum), nodding waternymph (Najas flexilis), and Canadian waterweed (Elodea canadensis).

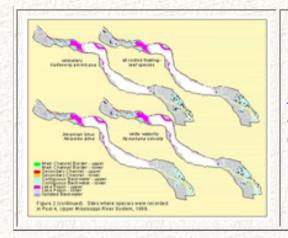


Figure 2. Continued. Species: wildcelery (*Vallisneria* americana), all rooted floating–leaf species, American lotus (*Nelumbo lutea*), and white waterlily (*Nymphaea odorata*).

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Vegetation - Stratified Random Sampling 1999

# 1999 Results in Pool 8 of the Upper Mississippi River

# **Sampling Efforts**

Sampling was conducted from June 21 to July 26, 1999. Of the 600 sites targeted, 595 were sampled (Figure 3).

# **Submersed Aquatic Vegetation**

The status of submersed aquatic vegetation (SAV) in Pool 8 varied among the strata sampled. Isolated and contiguous backwaters had the highest abundance of SAV (Table 3; Figure 4). Impounded areas, secondary channels, and main channel border followed in decreasing order. Beds of SAV were found throughout most of the shallow water areas, except in the main channel border areas and the lower fifth of the pool where beds were generally absent. The SAV covered about 58.1% of the shallow water areas poolwide.

A total of 16 species were recorded in the entire pool. Except the main channel border areas, each of the other four strata sampled harbored a rich assemblage of submersed plant species (10 or more species). Canadian waterweed, coontail, and water stargrass were the most abundant species recorded.

# **Rooted Floating-Leaf Vegetation**

White waterlily, American lotus, and yellow pond-lily were the three rooted floating—leaf species recorded. The percent cover of rooted floating—leaf species was the highest in the isolated backwaters. White waterlily was scattered in much of the isolated and contiguous backwaters, while American lotus and yellow pond-lily had a much more limited distribution. The three species together covered about 7.1% of the shallow water areas.



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**Table 3.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating—leaf vegetation in Pool 8, Upper Mississippi River System, 1999.

Common name	back	Contiguous backwater n = 172		ated water 28	Impounded n = 225	
(Scientific name)	Freq	Al	Freq	Al	Freq	Al
bladderwort, common ( <i>Utricularia macrorhiza</i> )	4.7 ± 1.6	0.5 ± 0.2	39.3 ± 9.4	4.3 ± 1.2	-	-
buttercup, longbeak ( <i>Ranunculus longirostris</i> )	1.7 ± 1.0	0.1 ± 0.1	-	-	-	-
chara ( <i>Chara</i> spp.)	2.9 ± 1.3	0.4 ± 0.2	21.4 ± 7.9	2.7 ± 1.0	-	-
coontail ( <i>Ceratophyllum demersum</i> )	72.7 ± 3.4	12.8 ± 0.9	89.3 ± 6.0	16.2 ± 1.8	4.4 ± 1.4	0.4 ± 0.1
pondweed, curly ( <i>Potamogeton crispus</i> )	28.5 ± 3.5	$3.3 \pm 0.5$	17.9 ± 7.4	1.7 ± 0.8	6.7 ± 1.7	0.7 ± 0.2
pondweed, flatstem ( <i>P. zosteriformis</i> )	25.6 ± 3.3	$3.5 \pm 0.5$	17.9 ± 7.4	$2.0 \pm 0.9$	1.3 ± 0.8	0.1 ± 0.1
pondweed, leafy/small ( <i>P. foliosus/pusillus</i> )	42.4 ± 3.8	5.8 ± 0.6	46.4 ± 9.6	6.0 ± 1.4	2.2 ± 1.0	0.2 ± 0.1
pondweed, longleaf (P. nodosus)	$7.6 \pm 2.0$	$0.9 \pm 0.3$	-	-	$0.4 \pm 0.4$	0.1 ± 0.1
pondweed, Richardson's ( <i>P. richardsonii</i> )	-	-	-	-	-	-
pondweed, sago ( <i>P. pectinatus</i> )	30.2 ± 3.5	$3.8 \pm 0.5$	10.7 ± 6.0	1.1 ± 0.6	17.8 ± 2.6	2.2 ± 0.4
stargrass, water ( <i>Heteranthera dubia</i> )	38.4 ± 3.7	4.6 ± 0.5	$3.6 \pm 3.6$	0.2 ± 0.2	27.6 ± 3.0	3.7 ± 0.5
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	27.9 ± 3.4	$3.6 \pm 0.5$	$3.6 \pm 3.6$	0.2 ± 0.2	6.7 ± 1.7	0.5 ± 0.1
watermilfoil, northern ( <i>M. sibiricum</i> )	-	-	*	*	-	-
		9/15 1.17 (4)	*	*		

Table 3. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

waternymph, nodding (Najas flexilis)	8.1 ± 2.1	1.3 ± 0.4	39.3 ± 9.4	5.2 ± 1.4	-	-
waterweed, Canadian ( <i>Elodea canadensis</i> )	65.1 ± 3.6	11.1 ± 0.9	57.1 ± 9.5	9.9 ± 2.3	12.9 ± 2.2	1.5 ± 0.3
wildcelery (Vallisneria americana)	5.8 ± 1.8	$0.8 \pm 0.3$	-	-	12.4 ± 2.2	1.7 ± 0.3
all submersed species	92.4 ± 2.0	19.7 ± 1.0	92.9 ± 5.0	19.8 ± 2.3	44.9 ± 3.3	$6.6 \pm 0.6$
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American ( <i>Nelumbo lutea</i> )	19.2 ± 3.0	7.2 ± 1.5	-	-	1.3 ± 0.8	1.2 ± 0.7
pond-lily, yellow ( <i>Nuphar variegata</i> )	2.9 ± 1.3	0.4 ± 0.2	-	-	-	-
(****)						
waterlily, white (Nymphaea odorata)	30.2 ± 3.5	10.1 ± 1.7	71.4 ± 8.7	48.6 ± 7.5	0.4 ± 0.4	<0.1± <0.1

<sup>\*</sup>Because of inaccuracies in the strata map and geographical information system's receiver, the contiguous backwater site containing northern watermilfoil was actually located in an isolated backwater.

Table 3. Continued.

Common name (Scientific name)	Main channel border n = 70		Secondary channel n = 100		Pool 8 n = 595	
	Freq	Al	Freq	Al	Freq	Al
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	<u>-</u>	-	-	2.8 ± 0.6	0.3 ± 0.1
buttercup, longbeak ( <i>Ranunculus longirostris</i> )	-	<u>-</u>	-	-	$0.5 \pm 0.3$	<0.1 ± <0.1
chara ( <i>Chara</i> spp.)	-	-	-	-	1.6 ± 0.5	0.2 ± 0.1
coontail (Ceratophyllum demersum)	4.3 ± 2.4	$0.3 \pm 0.2$	18.0 ± 3.9	1.8 ± 0.4	28.8 ± 1.3	$4.7 \pm 0.3$
pondweed, curly ( <i>Potamogeton crispus</i> )	7.1 ± 3.1	$0.6 \pm 0.3$	3.0 ± 1.7	0.3 ± 0.2	12.7 ± 1.3	1.4 ± 0.2
pondweed, flatstem (P. zosteriformis)	-	<u>-</u>	4.0 ± 2.0	0.5 ± 0.3	9.1 ± 1.2	1.2 ± 0.2
pondweed, leafy/small ( <i>P. foliosus/</i> pusillus)	1.4 ± 1.4	0.2 ± 0.2	3.0 ± 1.7	$0.3 \pm 0.2$	15.3 ± 1.3	2.0 ± 0.2
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	4.0 ± 2.0	$0.5 \pm 0.3$	$2.9 \pm 0.7$	0.3 ± 0.1

Table 3. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

pondweed, Richardson's ( <i>P. richardsonii</i> )	-	-	1.0 ± 1.0	0.1 ± 0.1	0.1 ± 0.1	<0.1 ± <0.1
pondweed, sago ( <i>P. pectinatus</i> )	15.7 ± 4.4	2.2 ± 0.6	14.0 ± 3.5	1.9 ± 0.5	20.4 ± 1.7	2.6 ± 0.2
stargrass, water ( <i>Heteranthera dubia</i> )	8.6 ± 3.4	1.0 ± 0.4	22.0 ± 4.2	2.7 ± 0.5	28.2 ± 1.9	3.6 ± 0.3
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	-	-	9.0 ± 2.9	0.8 ± 0.3	12.6 ± 1.3	1.4 ± 0.2
watermilfoil, northern ( <i>M. sibiricum</i> )	-	-	-	-	0.2 ± <0.1	<0.1 ± <0.1
waternymph, nodding (Najas flexilis)	-	-	-	-	$3.8 \pm 0.9$	0.6 ± 0.1
waterweed, Canadian (Elodea canadensis)	8.6 ± 3.4	0.7 ± 0.3	20.0 ± 4.0	2.7 ± 0.6	30.1 ± 1.6	4.7 ± 0.3
wildcelery ( <i>Vallisneria americana</i> )	14.3 ± 4.2	2.3 ± 0.7	8.0 ± 2.7	0.8 ± 0.3	9.5 ± 1.3	1.3 ± 0.2
all submersed species	25.7 ± 5.3	$3.8 \pm 0.9$	36.0 ± 4.8	5.2 ± 0.8	58.1 ± 1.9	10.5 ± 0.4
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American ( <i>Nelumbo lutea</i> )	-	-	4.0 ± 2.0	1.4 ± 0.9	6.6 ± 1.0	2.8 ± 0.5
pond-lily, yellow ( <i>Nuphar variegata</i> )	-	-	-	-	$0.8 \pm 0.4$	0.1 ± 0.1
waterlily, white (Nymphaea odorata)	-	-	4.0 ± 2.0	$0.6 \pm 0.3$	12.0 ± 1.1	$4.8 \pm 0.6$
all rooted floating-leaf species	-	-	$6.0 \pm 2.4$	1.8 ± 1.0	16.6 ± 1.2	$7.7 \pm 0.8$

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**Figure 4.** Sites where species were recorded in Pool 8, Upper Mississippi River System, 1999.

#### **Image Preview**

#### **Figure - Description**

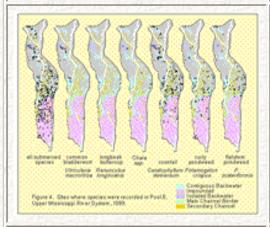


Figure 4. Species: all submersed species, common bladderwort (*Utricularia macrorhiza*), longbeak buttercup (*Ranunculus longirostris*), *Chara* spp., coontail (*Ceratophyllum demersum*), curly pondweed (*Potamogeton crispus*), and flatstem pondweed (*P. zosteriformis*).

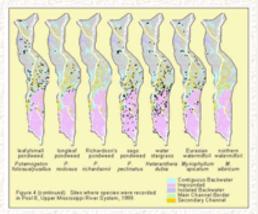


Figure 4. Continued. Species: leafy/small pondweed (*P. foliosus/pusillus*), longleaf pondweed (*P. nodosus*), Richardson's pondweed (*P. richardsonii*), sago pondweed (*P. pectinatus*), water stargrass (*Heteranthera dubia*), Eurasian watermilfoil (*Myriophyllum spicatum*), and northern watermilfoil (*M. sibiricum*).

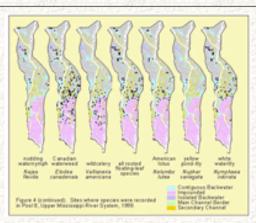


Figure 4. Continued. Species: nodding waternymph (*Najas flexilis*), Canadian waterweed (*Elodea canadensis*), wildcelery (*Vallisneria americana*), all rooted floating–leaf species, American lotus (*Nelumbo lutea*), yellow pond-lily (*Nuphar variegata*), and white waterlily (*Nymphaea odorata*).



Reports and Publications

Vegetation - Stratified Random Sampling 1999

# 1999 Results in Pool 13 of the Upper Mississippi River

# **Sampling Efforts**

Sampling was conducted in a total of 29 working days from June 16 to July 27, 1999 (Figure 5). Of the 550 sites targeted, all were sampled.

## **Submersed Aquatic Vegetation**

The abundance and frequency of submersed aquatic vegetation (SAV) varied among strata sampled. Isolated backwater sites had the highest abundance and frequencies followed by contiguous backwaters and impounded sites (<u>Table 4</u>; <u>Figure 6</u>). The SAV was rarely sampled in the main channel borders and secondary channels. The SAV covered about 42% of the shallow water areas poolwide.

A total of 14 species of SAV were collected in Pool 13 in 1999. Impounded sites contained the highest number of species with 12 present. The main channel border contained the least number of species with 4. The secondary channel sites, even though they exhibited a low frequency, contained 7 species. Sago pondweed and coontail were the dominant species in Pool 13. Within the impounded area, wildcelery was dominant. Eurasian watermilfoil was not encountered in the isolated backwater sites.

# **Rooted Floating–Leaf Vegetation**

American lotus and white waterlily were the only two rooted floating-leaf species encountered in Pool 13 and were sampled in all but the main channel border and secondary channel sites. Rooted floating—leaf species were encountered most often in backwater contiguous areas followed by isolated backwater areas. The two species together covered about 7.4% of the shallow water areas or areas where water depth measured 3 m or less at flat-pool.

Content manager: Dr. Yao Yin



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**Table 4.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 13, Upper Mississippi River System, 1999.

Common name	back	iguous water : 170	lsola backv n =		Impounded n = 210		
(Scientific name)	Freq.	Al	Freq.	Al	Freq.	Al	
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	10.0 ± 5.6	1.3 ± 0.8	-	-	
chara ( <i>Chara</i> spp.)	-	-	<u>-</u>	-	0.5 ± 0.5	0.1 ± 0.1	
coontail (Ceratophyllum demersum)	29.4 ± 3.5	4.5 ± 0.6	56.7 ± 9.2	17.1 ± 4.4	11.4 ± 2.2	1.8 ± 0.4	
pondweed, curly ( <i>Potamogeton crispus</i> )	8.2 ± 2.1	0.8 ± 0.2	16.7 ± 6.9	2.6 ± 1.1	4.3 ± 1.4	0.4 ± 0.1	
pondweed, flatstem (P. zosteriformis)	-	-	$3.3 \pm 3.3$	0.4 ± 0.4	-	-	
pondweed, leafy/small ( <i>P. foliosus/</i> pusillus)	2.9 ± 1.3	0.3 ± 0.1	16.7 ± 6.9	3.2 ± 1.3	3.3 ± 1.2	0.6 ± 0.2	
pondweed, longleaf ( <i>P. nodosus</i> )	1.8 ± 1.0	0.3 ± 0.2	10.0 ± 5.6	1.2 ± 0.7	3.3 ± 1.2	0.4 ± 0.2	
pondweed, sago ( <i>P. pectinatus</i> )	33.5 ± 3.6	5.6 ± 0.7	33.3 ± 8.8	5.3 ± 1.4	21.9 ± 2.9	2.5 ± 0.4	
stargrass, water ( <i>Heteranthera dubia</i> )	3.5 ± 1.4	0.3 ± 0.1	-	-	21.0 ± 2.8	2.2 ± 0.3	
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	1.2 ± 0.8	0.1 ± 0.1	-	-	13.8 ± 2.4	1.5 ± 0.3	
waternymph, nodding ( <i>Najas flexilis</i> )	$0.6 \pm 0.6$	<0.1 ± <0.1	13.3 ± 6.3	1.3 ± 0.7	1.4 ± 0.8	0.1 ± 0.1	
waternymph, southern ( <i>N. guadalupensis</i> )	$0.6 \pm 0.6$	<0.1 ± <0.1	$3.3 \pm 3.3$	0.2 ± 0.2	1.4 ± 0.8	0.2 ± 0.1	
waterweed, Canadian ( <i>Elodea canadensis</i> )	5.3 ± 1.7	$0.8 \pm 0.3$	20.0 ± 7.4	$2.3 \pm 0.9$	4.8 ± 1.5	0.6 ± 0.2	

Table 4. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

wildcelery (Vallisneria americana)	4.7 ± 1.6	$0.4 \pm 0.2$	-	-	26.2 ± 3.0	$5.2 \pm 0.7$
all submersed species	51.8 ± 3.8	9.0 ± 0.8	56.7 ± 9.2	18.1 ± 4.3	42.4 ± 3.4	$8.0 \pm 0.8$
	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American ( <i>Nelumbo lutea</i> )	35.3 ± 3.7	15.8 ± 2.3	33.3 ± 8.8	10.7 ± 3.8	8.6 ± 1.9	5.0 ± 1.3
waterlily, white (Nymphaea odorata)	8.2 ± 2.1	2.4 ± 0.9	6.7 ± 4.6	2.0 ± 1.7	6.7 ± 1.7	1.8 ± 0.6
all rooted floating-leaf species	37.1 ± 3.7	17.9 ± 2.5	33.3 ± 8.8	10.7 ± 3.8	10.5 ± 2.1	6.8 ± 1.5

Table 4. Continued.

Common name	Main ch bord n =	der	Secor char n =	nnel	Pool 13 n = 550		
(Scientific name)	Freq.	Al	Freq.	Al	Freq.	Al	
bladderwort, common ( <i>Utricularia macrorhiza</i> )	-	-	-	-	$0.6 \pm 0.3$	0.1 ± <0.1	
chara ( <i>Chara</i> spp.)	-	-	-	-	0.2 ± 0.2	<0.1 ± <0.1	
coontail (Ceratophyllum demersum)	-	-	$2.9 \pm 2.0$	$0.3 \pm 0.2$	19.0 ± 1.8	$3.4 \pm 0.4$	
pondweed, curly (Potamogeton crispus)	-	-	1.4 ± 1.4	0.2 ± 0.2	5.9 ± 1.1	0.6 ± 0.1	
pondweed, flatstem ( <i>P. zosteriformis</i> )	-	-	-	-	0.2 ± 0.2	<0.1 ± <0.1	
pondweed, leafy/small ( <i>P. foliosus/</i> pusillus)	-	-	1.4 ± 1.4	0.1 ± 0.1	$3.6 \pm 0.8$	0.6 ± 0.1	
pondweed, longleaf ( <i>P. nodosus</i> )	-	-	-	-	2.7 ± 0.7	0.4 ± 0.1	
pondweed, sago ( <i>P. pectinatus</i> )	11.4 ± 3.8	1.7 ± 0.6	8.6 ± 3.4	$0.9 \pm 0.4$	25.0 ± 1.9	3.6 ± 0.3	
stargrass, water ( <i>Heteranthera dubia</i> )	1.4 ± 1.4	0.3 ± 0.3	1.4 ± 1.4	0.1 ± 0.1	10.7 ± 1.3	1.1 ± 0.1	
watermilfoil, Eurasian ( <i>Myriophyllum spicatum</i> )	2.9 ± 2.0	0.2 ± 0.1	1.4 ± 1.4	0.1 ± 0.1	6.8 ± 1.1	0.7 ± 0.1	
waternymph, nodding (Najas flexilis)	-	-	-	-	1.6 ± 0.6	0.2 ± 0.1	
waternymph, southern (N. guadalupensis)	-	-	-	-	1.0 ± 0.5	0.1 ± 0.1	

Table 4. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

waterweed, Canadian (Elodea canadensis)	-	-	-	-	5.2 ± 1.0	0.7 ± 0.1
wildcelery ( <i>Vallisneria americana</i> )	1.4 ± 1.4	0.2 ± 0.2	1.4 ± 1.4	0.2 ± 0.2	13.4 ± 1.5	2.4 ± 0.3
all submersed species	11.4 ± 3.8	1.7 ± 0.6	10.0 ± 3.6	1.1 ± 0.4	41.9 ± 2.1	8.0 ± 0.5
	Freq	Cover	Freq	Cover	Freq	Cover
	rieq	Covei	rieq	Covei	rieq	Cover
lotus, American (Nelumbo lutea)	-	-	-	-	18.3 ± 1.6	
· ·	- -	-	- -	-	-	

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**Figure 6.** Sites where species were recorded in Pool 13, Upper Mississippi River System, 1999.

#### **Image Preview**



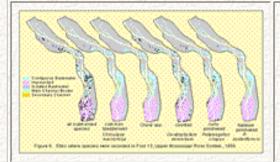


Figure 6. Species: all submersed species, common bladderwort (*Utricularia macrorhiza*), *Chara* spp., coontail (*Ceratophyllum demersum*), curly pondweed (*Potamogeton crispus*), and flatstem pondweed (*P. zosteriformis*).

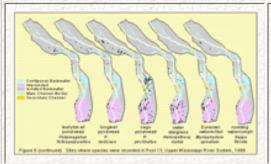
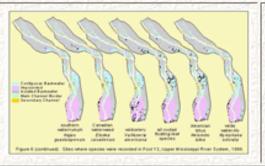


Figure 6. Continued. Species: leafy/small pondweed (*P. foliosus/pusillus*), longleaf pondweed (*P. nodosus*), sago pondweed (*P. pectinatus*), water stargrass (*Heteranthera dubia*), Eurasian watermilfoil (*Myriophyllum spicatum*), and nodding waternymph (*Najas flexilis*).



<u>Figure 6</u>. Continued. Species: southern waternymph (*Najas guadalupensis*), Canadian waterweed (*Elodea canadensis*), wildcelery (*Vallisneria americana*), all rooted floating–leaf species, American lotus (*Nelumbo lutea*), and white waterlily (*Nymphaea odorata*).



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# 1999 Results in Pool 26 of the Upper Mississippi River

## **Sampling Efforts**

Sampling in Pool 26 of the Upper Mississippi River System (UMRS) and lower Illinois River was conducted from June 17 to August 2, 1999 (Figure 7). Of the 650 sites targeted, 647 were sampled.

## **Submersed Aquatic Vegetation**

Submersed aquatic vegetation (SAV) was uncommon in Pool 26. Sago pondweed was the only SAV species encountered in 1999 and occurred in low frequency in isolated backwaters and main channel borders of the lower Illinois River and the impounded portion of Pool 26 (Table 5; Figure 8).

## Rooted Floating-Leaf Vegetation

Only two species of rooted floating—leaf vegetation were encountered in 1999. American lotus occurred in low frequencies in isolated backwaters of the lower Illinois River and contiguous backwaters and main channel borders of Pool 26 of the UMRS. Likewise, floating primrose-willow occurred in low frequencies and was encountered in isolated backwaters of the lower Illinois River.

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**Table 5.** Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 26, Upper Mississippi River System, 1999.

Common name	Contiguous backwater n = 80		back Miss Ri	lated water, issippi ver = 50	backv Illinois	ated vater, s River 160	Impounded <i>n</i> = 80		
(Scientific name)	Freq	Al	Freq	Al	Freq	Al	Freq	Al	
pondweed, sago (Potamogeton pectinatus)	-	-	-	-	1.3 ± 0.9	0.1 ± 0.1	1.3 ± 1.3	0.1 ± 0.1	
all submersed species	-	-	-	-	1.3 ± 0.9	0.1 ± 0.1	1.3 ± 1.3	0.1 ± 0.1	
	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover	
lotus, American (Nelumbo lutea)	1.3 ± 1.3	0.6 ± 0.6	-	-	2.5 ± 1.2	1.1 ± 0.6	-	-	
primrose-willow, floating ( <i>Ludwigia peploides</i> )	-	-	-	-	0.6 ± 0.6	0.1 ± 0.1	-	-	
all rooted floating-leaf species	1.3 ± 1.3	$0.6 \pm 0.6$	-	-	2.5 ± 1.2	1.3 ± 0.7	-	-	

Table 5. Continued.

Common name	Main c bord Missis Riv n =	der, ssippi ⁄er	bore	hannel der, s River : 50	Secondary channel n = 90		Pool 26 n = 647	
(Scientific name)	Freq	Al	Freq	Al	Freq	Al	Freq	Al
pondweed, sago (Potamogeton pectinatus)	-	-	2.0 ± 2.0	0.1 ± 0.1	-	-	0.6 ± 0.4	<0.1 ± <0.1

Table 5. Percent frequency, abundance index (AI), cover, and standard error...ed floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999.

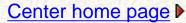
all submersed species	-	-	2.0 ± 2.0	0.1 ± 0.1	-	-	0.6 ± 0.4	<0.1 ± <0.1
	Freq	Cover	Freq	Cover	Freq	Cover	Freq	Cover
lotus, American (Nelumbo lutea)	2.2 ± 1.3	0.2 ± 0.1	-	-	-	-	1.5 ± 0.6	0.5 ± 0.2
primrose-willow, floating (Ludwigia peploides)	-	-	-	-	-	-	0.2 ± 0.2	<0.1 ± <0.1
all rooted floating-leaf species	2.2 ± 1.3	0.2 ± 0.1	-	-	-	-	1.5 ± 0.6	0.6 ± 0.3

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# 1999 Results in La Grange Pool of the Illinois River

## **Sampling Efforts**

Sampling for La Grange Pool was conducted from June 16 to August 6, 1999. Of the 550 sites targeted, 538 sites were sampled (Figure 9).

## **Submersed Aquatic Vegetation**

The status of submersed aquatic vegetation (SAV) in La Grange Pool in 1999 was the same among the strata sampled. There was no SAV recorded at any of the sites sampled during the SRS in any of the strata. River stage near Havana was at or above flood stage from mid-April through June, making growing conditions less than desirable for SAV (Table 6; Figure 10). However, several small- to medium-sized beds of sago pondweed were observed during an informal survey of the lower half of the reach in September. Other medium-sized beds of coontail were also observed in smaller isolated backwater lakes during SRS.

## Rooted Floating-Leaf Vegetation

American lotus was the only rooted floating—leaf species recorded in La Grange Pool. This species was recorded in both contiguous and isolated backwater lakes (0.2% and 0.1% cover, respectively). American lotus covered 0.1% of La Grange Pool.

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**Table 6.** Percent frequency, cover, and standard error of rooted floating–leaf vegetation in La Grange Pool, Illinois River, 1999.

Common name (Scientific		guous water 190	Isola backv n =	water	Ma chan bor n =	nel der	Secon char n =	nel		range ool 537
` name)	Freq	Cov	Freq	Cov	Freq	Cov	Freq	Cov	Freq	Cov
lotus, American (Nelumbo lutea)	0.5 ± 0.5	0.2 ± 0.2	0.5 ± 0.5	0.1 ± 0.1	-	_	-	-	0.5 ± 0.5	0.1 ± 0.1
all rooted floating–leaf species	0.5 ± 0.5	0.2 ± 0.2	0.5 ± 0.5	0.1 ± 0.1	-	-	-	-	0.5 ± 0.5	0.1 ± 0.1

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## **Summary**

## Longitudinal distribution

- Vegetation stratified random sampling was conducted in Pools 4, 8, 13, 26, and La Grange Pool in 1999.
- The estimated percent frequencies of submersed aquatic vegetation in the shallow water areas in Pools 4, 8, 13, 26, and La Grange Pool were 37.6%, 58.1%, 41.9%, 0.6%, and 0%, respectively (Tables 2, 3, 4, 5, and 6). The longitudinal pattern of submersed aquatic vegetation is the same as revealed in the previous year, 1998.
- This pattern is also consistent with the longitudinal pattern displayed in the aerial photographs of 1989 that submersed aquatic vegetation was abundant in the Upper Mississippi River reaches upstream of Lock and Dam 13, but rare or negligible elsewhere in the UMRS (Rogers and Theiling 1999). A deviation from this longitudinal pattern was observed after the 1987–89 drought and in 1993 after an unusually high flood disturbance, when little submersed aquatic vegetation occurred in the entire UMRS. We did not sample the entire UMRS in 1999, but we have no reason to suspect a deviation from the normal pattern occurred.
- The estimated percent frequencies of rooted floating-leaf vegetation in Pools 4, 8, 13, and 26, and La Grange Pool were 9.5%, 16.6%, 19.7%, 1.5%, and 0.5%, respectively (Tables).
- Rooted floating-leaf species shifted in dominance from white waterlily (Pools 4 and 8) to American lotus (Pools 13 and 26). This is the same longitudinal pattern as 1998.

## Within-pool Distribution

 The within-pool distribution patterns of submersed aquatic vegetation were highly heterogeneous between pools but remained little changed from 1998.

- Submersed aquatic vegetation was sparse and species-poor in upper Pool 4 above Lake Pepin compared with the lower Pool 4 below Lake Pepin (<u>Figure 2</u>). Rooted floating-leaf vegetation followed the same general pattern. The most common submersed species included coontail, Canadian waterweed and sago pondweed.
- Submersed aquatic and rooted floating-leaf vegetation was distributed widely throughout Pool 8 except in the lower end where water depth generally exceeded 1 m (<u>Figure 4</u>). The most common submersed species included Canadian waterweed, coontail, and water stargrass.
- A considerable amount of submersed aquatic vegetation was recorded in Pool 13, most of which occurred in the contiguous backwaters and impounded areas in the lower half of the pool (Figure 6). Most of the rooted floating-leaf vegetation was found in contiguous backwaters and along the shoreline in impounded areas in the lower half of the pool. The most common submersed species included sago pondweed and coontail.
- An insignificant amount of submersed aquatic and rooted floating—leaf vegetation
  was found in Pool 26, in the isolated backwater areas of the Illinois River (<u>Figure 8</u>).
- In La Grange Pool, submersed aquatic vegetation was absent in the river's backwater areas (Figure 10). Rooted floating-leaf vegetation was rare.
- The distribution of submersed aquatic vegetation appears to be correlated with the physical parameters of water depth, current velocity, and fetch.
- Two exotic submersed species have been recorded, Eurasian watermilfoil and curly pondweed. Both were found in Pools 4, 8, and 13. Neither species has been dominant, occurring in 15% or less of the sites in all pools in 1998 and 1999.

## **Status and Trend**

 1999 was only the second year in which SRS was conducted; therefore, a status and trend assessment is not provided.

► Summary of Fiscal Year 1999 Findings for the Long Term Resource Monitoring Program of the Upper Mississippi River System



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## **Tables**

- 1. Aquatic area strata and the number of sites sampled by pool, 1999.
- 2. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 4, Upper Mississippi River System, 1999
- 3. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating-leaf vegetation in Pool 8, Upper Mississippi River System, 1999
- 4. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 13, Upper Mississippi River System, 1999
- 5. Percent frequency, abundance index (AI), cover, and standard errors of submersed and rooted floating–leaf vegetation in Pool 26, Upper Mississippi River System, 1999
- 6. Percent frequency, cover, and standard error of rooted floating-leaf vegetation in La Grange Pool, Illinois River, 1999

Note: Tables are updated as errors are found and corrected. Please refer to the last updated date when using the information.

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**Figure 8.** Sites where species were recorded in Pool 26, Upper Mississippi River System, 1999.

# Image Preview Image Preview Important State Important

#### **Figure - Description**

Figure 8. Species: all submersed species, sago pondweed (*Potamogeton pectinatus*), all rooted floating–leaf species, American lotus (*Nelumbo lutea*), and floating primrose-willow (*Ludwigia peploides*).

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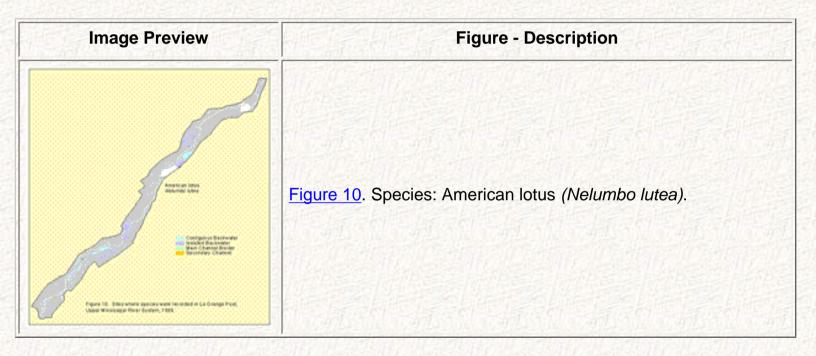
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**Figure 10.** Sites where species were recorded in La Grange Pool, Upper Mississippi River System, 1999.



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Wegetation - Stratified Random Sampling 1999

# **Appendix**

Submersed and rooted floating–leaf species found during stratified random sampling in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River.<sup>a</sup>

Common name	Scientific name	Species code	Family		
Submersed					
bladderwort, common	Utricularia macrorhiza Le Conte synomny <i>U. vulgaris</i> L.	UTMA	Lentibulariaceae		
buttercup, longbeak	ercup, longbeak Ranunculus longirostris Godr.b		Ranunculaceae		
chara	Chara spp.	CH?AR	Characeae		
coontail, coon's tail	Ceratophyllum demersum L.	CEDE4	Ceratophyllaceae		
pondweed, alpine	Potamogeton alpinus Balbis	POAL8	Potamogetonaceae		
pondweed, curly (curlyleaf)	P. crispus L.	POCR3	Potamogetonaceae		
pondweed, horned	Zannichellia palustris L.	ZAPA	Zannichelliaceae		
pondweed, leafy	Potamogeton foliosus Raf.	POFO3	Potamogetonaceae		
pondweed, leafy/small	P. foliosus Raf./P. pusillus L.	NLPW	Potamogetonaceae		
pondweed, longleaf (American)	P. nodosus Poir	PONO2	Potamogetonaceae		
pondweed, ribbonleaf	P. epihydrus Raf.	POEP2	Potamogetonaceae		
pondweed, Richardson's	P. richardsonii (Benn.) Rydb.	PORI2	Potamogetonaceae		
pondweed, sago	P. pectinatus L. synonymy Stuckenia pectinatus (L.) Boerner	POPE6	Potamogetonaceae		
pondweed, small	P. pusillus L.	POPU7	Potamogetonaceae		
pondweed, flatstem	P. zosteriformis Fern.	POZO	Potamogetonaceae		
stargrass, water (grassleaf mudplantain)	Heteranthera dubia (Jacq.) MacM. synonymy Zosterella dubia Jacq.	ZODU	Pontederiaceae		
watermilfoil, Eurasian (spike)	Myriophyllum spicatum L.	MYSP2	Haloragaceae		

watermilfoil, northern (shortspike)	M. sibiricum Komarov	MYSI	Haloragaceae
waternymph, brittle	Najas minor All.	NAMI	Najadaceae
waternymph, nodding (slender naiad)	N. flexilis (Willd.) Rostk. and Schmidt	NAFL	Najadaceae
waternymph, southern	N. guadalupensis (Spreng.) Magnus	NAGU	Najadaceae
waterweed, Canadian	Elodea canadensis Michx.	ELCA7	Hydrocharitaceae
wildcelery (American eelgrass)	Vallisneria americana Michx.	VAAM3	Hydrocharitaceae
Rooted floating-leaf			
lotus, American	Nelumbo lutea Willd.	NELU	Nelumbonaceae
pond-lily, yellow	Nuphar variegata Durand <sup>c</sup>	NULU	Nymphaeaceae
primrose-willow, floating	Ludwigia peploides (Kunth) Raven	LUPE5	Onagraceae
waterlily, white	Nymphaea odorata Ait. synomny N. tuberosa Paine	NYTU	Nymphaeaceae

<sup>&</sup>lt;sup>a</sup>Scientific nomenclature and common names follow the USDA's PLANTS database (<a href="http://plants.usda.gov/">http://plants.usda.gov/</a>). Common names used by Upper Mississippi River managers are also included.

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bRanunculus longirostris and R. trichophyllus were combined (Voss 1985).

Scientific nomenclature follows Gleason and Cronquist (1991). *Nuphar lutea* (L.) sm ssp. *variegata* (Dur.) E. O. Beal in PLANTS database.



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Table 1. Aquatic area strata and the number of sites sampled by pool, 1999.

Stratum description	Stratum numeric code	Stratum letter code	Pool 4	Pool 8	Pool 13	Pool 26	La Grange Pool
1999 sampling season							
Main channel border, Illinois River	1502	MCB-I	-	-	-	50	-
Main channel border	1503	МСВ	_	70	70	137	120
Secondary channel	1504	SC	-	100	70	90	40
Main channel border, upper	1505	MCB-U	12	-	-	-	-
Main channel border, lower	1506	MCB-L	48	-	-	-	-
Secondary channel, upper	1507	SC-U	61	-	-	-	-
Secondary channel, lower	1508	SC-L	59	-	-	-	-
Contiguous backwater	1510	BWC	-	172	170	80	190
Contiguous backwater, upper	1511	BWC-U	75	-	-	-	-
Contiguous backwater, lower	1512	BWC-L	160	-	-	-	-
Lake Pepin, upper	1513	TDL-U	65	-	-	-	-
Lake Pepin, lower	1514	TDL-L	35	-	-	-	-
Impounded	1520	IMP	-	225	210	80	-
Isolated backwater	1530	BWI	32	28	30	50	188
Isolated backwater, Illinois	1531	BWI	-	-	-	160	-
Total for 1999 sampling season			547	595	550	647	538

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## **Figures**

- 1. Aquatic area strata and sampling points in Pool 4, Upper Mississippi River System, 1999.
- 2. Sites where species were recorded in Pool 4, Upper Mississippi River System, 1999.
- 3. Aquatic area strata and sampling points in Pool 8, Upper Mississippi River System, 1999.
- 4. Sites where species were recorded in Pool 8, Upper Mississippi River System, 1999.
- 5. Aquatic area strata and sampling points in Pool 13, Upper Mississippi River System, 1999.
- 6. Sites where species were recorded in Pool 13, Upper Mississippi River System, 1999.
- 7. Aquatic area strata and sampling points in Pool 26, Upper Mississippi River System, 1999.
- 8. Sites where species were recorded in Pool 26, Upper Mississippi River System, 1999.
- 9. Aquatic area strata and sampling points in La Grange Pool, Upper Mississippi River System, 1999.
- 10. Sites where species were recorded in La Grange Pool, Upper Mississippi River System, 1999.

Content manager: Dr. Yao Yin

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http://www.umesc.usgs.gov/reports\_publications/ltrmp/veg/1999/figures.html

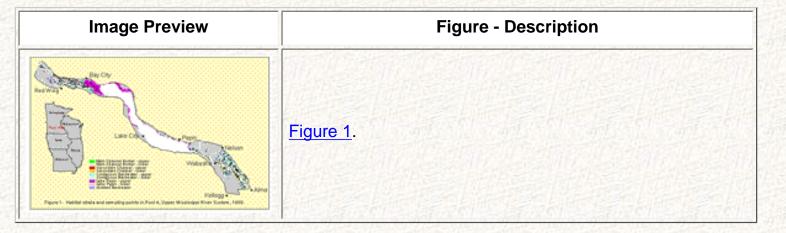
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Reports and Publications

Wegetation - Stratified Random Sampling 1999

**Figure 1.** Aquatic area strata and sampling points in Pool 4, Upper Mississippi River System, 1999.



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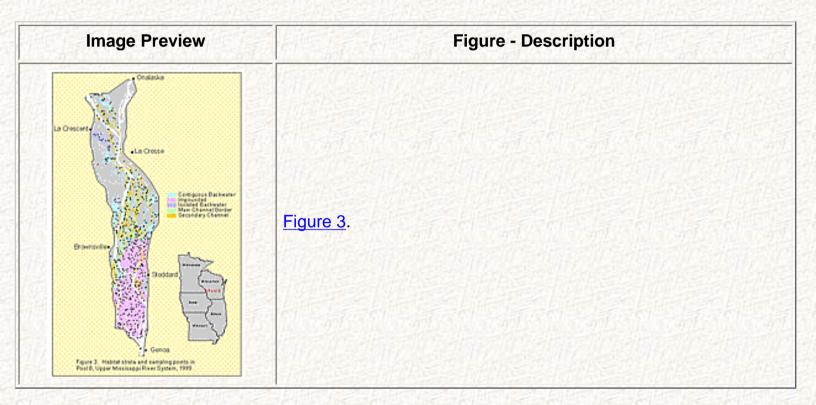
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**Figure 3.** Aquatic area strata and sampling points in Pool 8, Upper Mississippi River System, 1999.



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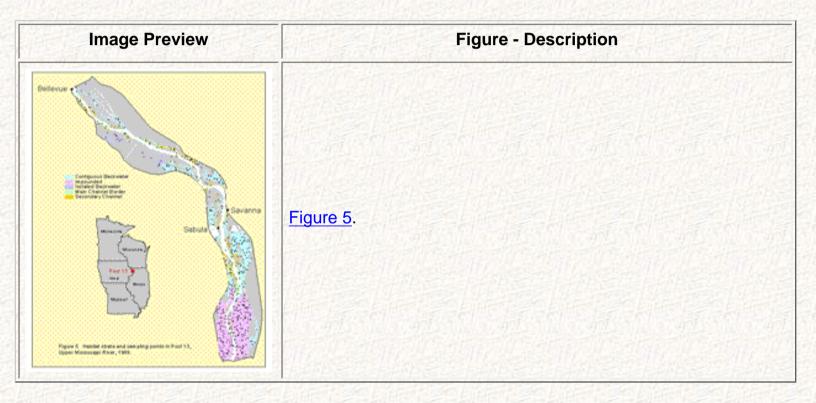
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**Figure 5.** Aquatic area strata and sampling points in Pool 13, Upper Mississippi River System, 1999.



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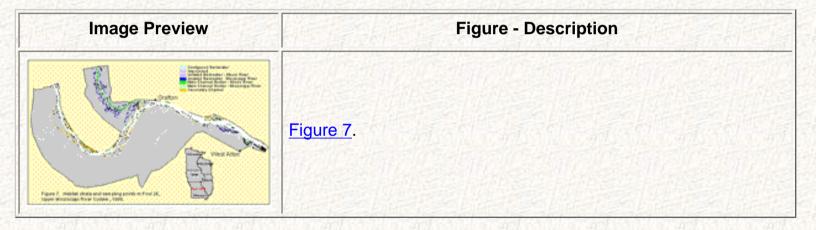
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**Figure 7.** Aquatic area strata and sampling points in Pool 26, Upper Mississippi River System, 1999.



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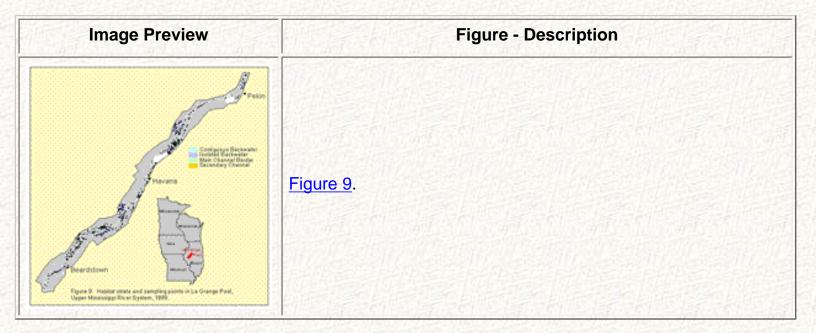
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Reports and Publications

Vegetation - Stratified Random Sampling 1999

**Figure 9.** Aquatic area strata and sampling points in La Grange Pool, Upper Mississippi River System, 1999.



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http://www.umesc.usgs.gov/ reports\_publications/ltrmp/veg/1999/tables/fig09poollag.html

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